

Teachers' Orientations Toward Mathematics Curriculum Materials: Implications for Teacher Learning

Janine T. Remillard
University of Pennsylvania

Martha B. Bryans
Haverford Friends School

This study was prompted by the current availability of newly designed mathematics curriculum materials for elementary teachers. Seeking to understand the role that reform-oriented curricula might play in supporting teacher learning, we studied the ways in which 8 teachers in the same school used one such curriculum, *Investigations in Number, Data, and Space* (TERC, 1998). Findings revealed that teachers had orientations toward using curriculum materials that influenced the way they used them regardless of whether they agree with the mathematical vision within the materials. As a result, different uses of the curriculum led to different opportunities for student and teacher learning. Inexperienced teachers were most likely to take a piloting stance toward the curriculum and engage all of its resources fully. Findings suggest that reform efforts might include assisting teachers in examining unfamiliar curriculum resources and developing new approaches to using these materials.

Key words: Curriculum; Elementary K–8; Materials (texts, other resources); Professional development; Reform in mathematics education; Teacher beliefs

A curriculum is more for teachers than it is for pupils. If it cannot change, move, perturb, inform teachers, it will have no effect on those whom they teach. It must be first and foremost a curriculum for teachers. If it has any effect on pupils, it will have it by virtue of having had an effect on teachers. (Bruner, 1960/1977, p. xv)

Since Jerome Bruner wrote these words in the preface to a new edition of *The Process of Education*, mathematics education has witnessed two flurries of curriculum material development aimed at fomenting change in mathematics

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curriculum and pedagogy in U.S. classrooms. In 1977, Bruner's remarks were directed at the first wave of curriculum development in the 1950s and 1960s, often referred to as the post-Sputnik era. During this time, numerous scientists and mathematicians were called on to design curriculum materials that would prepare the next generation of citizens to be scientifically competitive. These curriculum materials were designed with students, not teachers, in mind. In fact, they "overestimated the materials' independent educative power" and underestimated the influence of the teacher in their use (Cohen & Barnes, 1993, p. 215). And, as Bruner predicted, they had little lasting effect on students or pedagogical practices in American classrooms. Studies of the post-Sputnik curriculum reforms as well as more recent examinations of attempts to use curriculum materials to prompt change in teaching have suggested that the ways teachers read, interpret, and use curriculum materials are shaped by their knowledge of and views about mathematics (Graybeal & Stodolsky, 1987; Lloyd, 1999; Thompson 1984), perceptions of external pressures (Floden, Porter, Schmidt, Freeman, & Schwille, 1980; Kuhs & Freeman, 1979), ideas about the purpose of school and the nature of learning (Donovan, 1983; Stephens, 1982), and established routines and practices (Cohen, 1990; Remillard, 1992). Findings such as these led Cohen and Barnes (1993) and others (e.g., Ball, 1994) to argue that real pedagogical change could not occur without significant teacher learning. In order to teach differently, teachers need opportunities to learn mathematics in new ways and to consider new ideas about teaching and learning.

To a large extent, those involved in current reform efforts, prompted in the 1990s by calls for teachers to empower students as mathematical thinkers (National Council of Teachers of Mathematics [NCTM], 1989, 1991), have heeded the warnings of scholars about the impossibility of teacher-proof curricula and the importance of teacher learning. A large number of reform efforts have focused on constructing and fostering opportunities for teachers to learn more about mathematics teaching through activities such as exploring mathematics, examining students' understandings, analyzing pedagogical practices, and critiquing their own teaching (Schifter, Bastable, & Russell, 1999; Stein, Smith, Henningsen, & Silver, 2000; Wilson & Berne, 1999).

This emphasis on teacher learning has evolved simultaneously with the development of reform-driven curriculum materials. In fact, some studies of teacher development projects have identified a need for teachers in the process of pedagogical change to have well-designed curricular guidance, noting that teachers who have begun to think about mathematics teaching and learning differently are likely to struggle with how to use these ideas in their classrooms (Brown, Smith, & Stein, 1996). To this end, in the current wave of curriculum development some developers have taken up the task of designing curriculum materials that provide teachers with guidance for classroom instruction, but that also foster teachers' learning as they use them. Such curricula, Remillard (2000) has argued elsewhere, would need to speak *to* teachers, rather than *through* them.

Because such curriculum materials are fairly new, few researchers have explored how teachers use them or the extent to which the materials, in practice, support

teacher learning. In their studies of teachers piloting new materials, Lloyd (1999) and Collopy (2003) found variation in the ways the teachers read, interpreted, and used the teachers' guides. Both argued that teachers' particular beliefs and the specific features of the curriculum contributed to this variation.

Seeking greater understanding of the relationship between use of Standards-based curriculum materials¹ and teacher learning, we examined the ways in which 8 teachers in the same school used one such curriculum, *Investigations in Number, Data, and Space* (TERC, 1998). The question underlying our research was whether and how these curriculum materials might support teacher learning. We believe, as do the developers of the *Investigations* curriculum, that it is not enough to merely adopt a new curriculum and hand it to teachers—even one that is written with teacher learning in mind. Thus, our goal was to look closely at how teachers engaged with a specific reform curriculum and to understand how their use of these materials did or did not provide opportunities for their learning. This understanding can offer insights about the potential as well as the limitations of Standards-based curricula as vehicles for teacher learning and has implications for the kinds of support structures that might be provided for teachers as they use and learn from curricula like *Investigations*.

The site of this study was an ethnically and economically diverse urban, public elementary school. Although the questions central to this study are relevant to teachers in all schools, we believe that they are particularly relevant to those in urban settings. Urban schools face tremendous pressures to produce results in terms of student achievement and increased test scores (Carnoy, Elmore, & Siskin, 2003). However, typical characteristics of urban schools like large class sizes, limited resources, shifting bureaucratic policy, and rapid teacher turnover make any sort of pedagogical innovation difficult, especially one that places high demands on teachers (Weiner, 1999). It is common in these settings for district personnel to routinely adopt new published curriculum programs as a proxy for curricular reform. If curriculum materials are to make a substantial contribution to change in urban schools, we need a clearer understanding of the means by which such resources might support productive learning for teachers in these settings.

THEORETICAL FRAMEWORK

Our analysis and the assumptions underlying it were informed by what Doyle (1993) has called teachers' "curriculum processes"—the processes through which teachers construct or enact curriculum. From this perspective, curriculum, often referred to as *enacted curriculum*, is not what is written in textbooks or policy guidelines; it is what actually takes place in the classroom (Clandinin & Connelly, 1992). Studies of teachers' curriculum processes include examinations of how

¹ We use the term "Standards-based" to refer to curriculum materials developed in response to the NCTM's Standards documents (e.g., NCTM, 1989).

teachers draw on resources like curriculum guides; they also assume that doing so involves interpreting the meanings and intents of these resources (Doyle, 1993; Lemke, 1990; Snyder, Bolin, & Zumwalt, 1992). It is our view that the enacted curriculum is coconstructed by teachers and students as they participate in classroom events. We assume that a critical component of the work of enacting the curriculum is interpreting and responding to the words and actions of students. However, the focus of our analysis is restricted to the teacher's work in the curriculum enactment process.

Our attention to the enacted curriculum is informed by Remillard's (1996, 2000) studies of how teachers make sense of and use a reform-based textbook. Findings from this research revealed that minimal teacher learning resulted from merely reading the teachers' guide. Rather, the most significant learning occurred during teachers' processes of enacting curriculum in the classroom. Teachers' ideas about mathematics, teaching, and learning were challenged and altered when they examined unfamiliar mathematical tasks and interpreted students' work on them while teaching. The role of the textbook was to offer novel tasks or concepts that the teachers drew on when constructing curriculum with students. Thus, we see the process of enacting Standards-based curriculum as a potential place for teacher learning. However, because we assume that teachers use suggestions in the curriculum differently, we refer to them as *opportunities for learning*.

Our work is grounded in research on the relationship between teachers' knowledge and beliefs about mathematics, teaching, and learning and their practices in the classroom (e.g., Fennema & Franke, 1992; Thompson, 1992). Researchers have found that close analyses of teachers' beliefs and mathematical knowledge can explain how teachers structure their lessons (Thompson, 1984), respond to students (Carpenter, Fennema, Peterson, Chiang, & Loef, 1989), and receive and interpret new policy initiatives and curriculum (e.g., Putnam, Heaton, Prawat, & Remillard, 1992). These findings challenge naïve assumptions that it might be possible to achieve a direct and linear link between curriculum materials and teaching or between curriculum materials and teacher learning. However, it is worth noting that policy decisions often assume some degree of simplicity in the relationship between the adopted curriculum program and the enacted curriculum (Corcoran, 2003).

Research that examines teachers' beliefs in relation to practice further indicates that these relationships themselves are complex and are easily depicted in oversimplified terms. Thompson (1992), for example, found instances of internal conflict within teachers' beliefs. She used the term *integratedness* of belief structures to refer to the extent to which one's "beliefs and views in a given domain form a coherent conceptual system, as opposed to each belief existing in isolation from others" (p. 122). Similarly, Raymond (1997) noted inconsistency amongst beliefs and between beliefs and practice. In her study of a beginning mathematics teacher, Raymond found closer alignment between the teacher's practices and her professed beliefs about mathematics, which were established through her experience as a mathematics student, than her professed beliefs about pedagogy, which were developed in her teacher education program. Of equal importance, Raymond found that the

teacher's practices and related beliefs were mediated by a host of contextual factors, including elements of the immediate teaching context and students' experiences. This finding reflects Engeström's (1999) notion that one's beliefs, knowledge, and practices are situated socially and historically and must be understood in relation to the particular context. Assuming that teachers' curriculum use was mediated by personal and contextual factors, our goal in this study was to develop a detailed and nuanced understanding about the relationship among curriculum materials, the enacted curriculum, and the possibilities for teacher learning.

METHOD

Research Site: Carter Elementary School

Carter, a public elementary school in an urban district in the eastern United States, was atypical of the surrounding elementary schools for several reasons. First, the school was smaller than most local public schools (approximately 280 students in Grades K–4), and second, the student population was racially and socioeconomically diverse. Carter was located in a low-income, predominantly African American community; however, the district's efforts to achieve racial integration, begun in the 1970s, permitted children from outside the immediate neighborhood to transfer into designated schools. For a variety of reasons, Carter received a number of white, middle class children as transfer students. At the time of the study, the student population was 60% African American, 30% White, 7% Asian, and approximately 3% Latino. According to the district, 61% of the students were from low-income families. The teaching staff at Carter was 35% African American and 65% White.

Another distinguishing characteristic of Carter was its history as a progressive school. When it first opened in the early 1970s, the school offered an open-classroom track and a formal or traditional track from which parents could select. At the time of the study, the two-track system no longer existed, and practices formerly associated with the open track, such as school-wide, integrated theme studies and literature-based reading instruction, were encouraged throughout the school.

A final distinguishing feature of Carter was the school-wide emphasis on teacher development and, in particular, improving mathematics teaching. A new principal, committed to improving mathematics teaching and learning through professional development, furthered this emphasis in 1997 and 1998. As with many school-based initiatives, teachers engaged in the associated activities with differing levels of enthusiasm and commitment. The decision to adopt a new, reform-oriented curriculum—Investigations in Numbers, Data, and Space (TERC, 1998)—had been reached by over half the teachers when they attended a summer professional development program in 1998. The following summer, most of the teachers in the school, along with the principal, attended a week-long session sponsored by the curriculum developers.

The Investigations Curriculum

Investigations in Numbers, Data, and Space was developed with support from the National Science Foundation to further efforts to foster mathematical thinking and understanding in the elementary grades. The Investigations curriculum is different from conventional materials in two ways. First, it provides a carefully planned curriculum for students' mathematics learning that reflects the vision put forth by the NCTM's *Standards* documents (NCTM, 1989, 1991). Second, because the developers believe that teachers are critical players in the reform process, the curriculum materials are designed to support teacher learning. They include information for the teacher in the form of mathematical explanations, examples of student work and talk, summaries of relevant research, and suggestions for assessment. The developers include the following statement in the introduction to each unit guide: "Because we believe strongly that a new curriculum must help teachers think in new ways about mathematics and about their students' thinking processes, we have included a great deal of materials to help you learn more about both" (TERC, 1998, p. 6).

Participating Teachers

Beginning in fall 1998, we began our study at Carter Elementary School, and 7 of the 11 classroom teachers in the school agreed to participate. Table 1 provides information about these 7 teachers as well as an additional teacher, Maryanne Graves, who began teaching at Carter and joined the study in the fall of 1999. The names used in the table and throughout this article are pseudonyms. As is evident from the information in Table 1, Carter teachers are distinctive in their long teaching careers and their length of service at the school. In particular, half of the teachers have taught for 25 years or more, and three of them have spent most of their careers at Carter. One teacher (Myra Larson) left the school after the 1st year of the study and was replaced by another teacher (Maryanne Graves) who agreed to participate in the study during its 2nd year.

Table 1
Information About the Teachers in the Study

Teacher	Grade	Years teaching	Years at Carter
Kim Reston	1	30	26
Zoe Kitcher	3	25	25
Peter Jackson	4	30	30
Gloria Adler	2	28	12
Selene Baldwin	2	12	10
Laura Schwarz	4	3	3
Myra Larson	1	3	3
Maryanne Graves	1	4	1

Note. Larson and Graves participated in the study for 1 year each. Larson left the school after the 1st year and Graves replaced her in the fall of 1999. Thus, Graves began using the Investigations curriculum in the fall of 1999, her 4th year of teaching, but the 2nd year of the study.

Data Collection

The first 2 years that Investigations was used throughout Carter and the first 2 years of the current study corresponded with the pilot year and initial year of a 5-year study of mathematics teaching and student learning in an urban elementary school, directed by the first author. The aim of the 5-year study was to examine the relationship among teachers' beliefs and capacities, teachers' and students' classroom practices, and students' mathematical thinking and understandings. The 8 teachers (7 each year of the study) who volunteered to participate attended a monthly study-group meeting and related research activities. The study group meeting involved mathematical explorations and discussions about teaching mathematics. At the request of the teachers, these discussions frequently focused on using the newly adopted Investigations curriculum, which was unfamiliar in both form and content.

Because of its status as a pilot study for the 5-year project, data collection during the 1998–99 school year (which in this article we refer to as Year 1) was much less extensive than during the full study, which began in the fall of 1999 (which we refer to here as Year 2). During Year 1, each teacher was observed between two and four times, depending on his or her level of comfort, and was interviewed at least twice. During Year 2 of the study, 6 of the 7 teachers were observed seven to eight times over the year and were interviewed three times. Two of the teachers' classrooms were designated as *focus classrooms* and were observed daily over a 2-week period four times during the year. These teachers were interviewed approximately five times. The second author and a project researcher undertook all observations and interviews in Year 1. In Year 2, the second author and different project researchers undertook all observations and interviews. In almost all cases, these observations were prearranged with the teachers. Throughout both years of the study reported in this article, the first author, who was the project director, visited each teacher's classroom monthly to observe informally and speak to them about mathematics teaching or the Investigations curriculum.

During each formal observation, the observer audiotaped the lesson and took written fieldnotes and later used these artifacts to complete a predesigned observation instrument.² The completed instrument included a narrative summary of the lesson, a breakdown of the lesson into segments that were then analyzed for mathematical focus, and answers to general analytic questions regarding the overall emphasis of the lesson, the role of the curriculum, students' and teacher's role, and the nature of the learning opportunities available. Each lesson segment was determined by the central task in which students engaged. For each segment, the observer recorded the amount of time devoted to the task and described it, the teacher's aim and focus as could be determined by how the teacher implemented the task, and how the students engaged in the task. This information was then supported by illus-

² The observation instrument was adapted from Remillard (1996) and the Classroom Observation Instrument used in the QUASAR project (Stein, Grover, & Henningsen, 1996).

trative examples as were the answers to the analytical questions. The analytical questions asked about specific features of the lesson including the nature of the discourse (the extent to which it was divergent or convergent and who spoke to whom), the kinds of mathematical thinking emphasized during the lesson, and the role the curriculum materials played. At the beginning of each year of the study, once the first set of observations was completed and written up, the research team developed and recorded procedures for segmenting the lessons, characterizing the segments, and responding to the analytical questions. Subsequent meetings involved a collaborative review of completed instruments in order to resolve differences in how segments were selected or characterized.

The semistructured interviews, which we audiotaped and transcribed, focused on the teachers' views about mathematics, teaching, student learning, the curriculum materials, their own learning, as well as their thoughts about recent lessons that we had observed. Because the focus of the larger study was mathematics teaching in general and not the Investigations curriculum, our interactions with the teachers did not focus on the curriculum alone. Moreover, we emphasized in our interactions with the teachers that our study was not an assessment of their use of a specific curriculum. The broader focus of the study enabled us to examine teachers' curriculum use as one dimension of their mathematics teaching and invited teachers to speak openly about their views of the curriculum. At the same time, because the broader study involved open conversations about teaching and the curriculum with the project director, it is possible that some participating teachers provided responses that they believed we wanted to hear during interviews.

Data Analysis

The analysis was undertaken collaboratively by both authors and had two primary aims: (1) analysis of teachers' beliefs and perceptions primarily reflected in the interview data, and (2) analysis of teachers' classroom practices gleaned through classroom observations. We agreed on definitions for all codes before coding independently, checked for agreement regularly, and used disagreements to clarify code definitions. To analyze the interview data, we began by focusing on each teacher individually before looking for patterns and contrasts across the teachers. We coded each interview for evidence of beliefs about mathematics, teaching, and learning, as well as perceptions of and relationship to the curriculum and past experiences with other curricula. We also looked for patterns or changes in their use of curriculum materials over teaching careers. Once we had established patterns that allowed us to characterize each teacher's beliefs and perceptions, we examined the 8 teachers comparatively. The construct of *orientation toward the curriculum* (which we describe in detail in the results section) emerged when we observed overlaps in some teachers' espoused beliefs about mathematics teaching and learning but contrasts in their views of the curriculum. Although we found patterns in teachers' orientations (which overlapped with their use of the curriculum), each teacher's orientation as we identified it was somewhat unique to the particular

teacher's set of beliefs and perspectives. Thus, we selected a unique term to identify each teacher's orientation that reflected that teacher's views on the curriculum and captured his or her approach to using the curriculum as reflected in both interview and observation data.

We also analyzed the interview data for evidence of opportunities for learning that resulted from the teacher's use of the curriculum. We defined opportunities for learning as events or activities that are likely to unsettle or expand teachers' existing ideas and practices by presenting them with new insights or experiences (Ball, 1994; Bruner, 1960/1977; Remillard, 2000). We examined opportunities generated through reading the curriculum materials, planning instruction, and the process of enacting curriculum in the classroom. We coded explicit references teachers made to changed beliefs or teaching practices, new understandings, and insights that resulted from using the curriculum for the nature of change and what the teacher attributed it to. We also looked for changes in the teacher's beliefs or understandings reflected in their conversations during the interview over the 2 years.

Analysis of the observational data also began with a focus on each teacher individually and had two purposes. First, we sought to understand how the teachers used the curriculum and the role that it played in their teaching. Second, we sought to characterize their teaching and the kinds of mathematical knowledge emphasized. Using the completed observation instruments for each lesson and transcriptions of postobservation conversations with the teacher, we categorized each lesson segment according to its source (e.g., Investigations Curriculum, teacher design, or other resources) and mathematical emphasis. In both cases, we predetermined the categories used but refined them as they were used. For example, we developed new categories or expanded existing ones to accommodate the patterns that emerged from the data. Lessons identified as "guided by Investigations" were those where the teacher used the curriculum as a source of tasks, structure, and overall flow of the lesson for at least half of the session. We placed lessons in this category when we saw evidence that the teacher used the curriculum guide to structure class discussions and to introduce tasks in addition to the tasks themselves. When the lesson consisted primarily of activities drawn from Investigations, but the entire lesson (e.g., introduction, discussion, etc.) did not reflect the outline in the curriculum, we identified it as "activity drawn from Investigations." The lessons identified as "activity adapted from Investigations" refer to those in which the teacher significantly changed an activity drawn from a lesson in the curriculum. In the cases where at least half of the lesson was not related to the curriculum at all, we labeled it as either drawn from another resource ("other resource") or designed by the teacher ("own design"), using the teacher's self-report to make this determination. The identified sources for all observed lessons are summarized in Table 2.

In order to capture the extent to which the teachers used the Investigations curriculum to guide their teaching, we used the three central domains of teaching described in Remillard's (1999) framework: (a) curriculum mapping, that is, the structure of the entire curriculum, including the mathematical topics and concepts, how they are sequenced, and the time devoted to each; (b) curriculum design, that

Table 2
Summary of Primary Curriculum Sources of Observed Lessons

Teacher	Number of times observed	Grade level	Source for at least half of the observed lesson					Comments
			Guided by Investi-gations	Activity drawn from Investi-gations	Activity adapted from Investi-gations	Other resource	Own design	
Jackson	9	4	0	4	1	3	1	Used commercially published text for homework and 2 lessons.
Reston	10	1	0	3	2	4	1	Use of Investigations was concentrated around end of the 2 years.
Baldwin	27	2	3	12	11	0	1	Used same warm-up activity for 12 of 27 lessons.
Adler	10	2	1	3	2	2	2	Often adapted activities for use in mathematics centers.
Kitcher	15	3	7	0	3	4	1	
Schwarz	26	4	13	2	4	3	4	
Graves ^a	8	1	6	0	2	0	0	
Larson ^b	4	1	4	0	0	0	0	

^aGraves began teaching at Carter during the fall of 1999.

^bLarson left the school in the spring of 1999.

is, the tasks that the teachers selected, adapted, or designed to present to students; and (c) enacted curriculum, that is, how they enacted the tasks in the classroom.³ In addition to using the patterns of sources for the observed lessons represented in Table 2, we used interviews and observations to determine the role the curriculum played in each domain for each teacher. From the pattern that emerged, we developed three broad categories of use evident among these 8 teachers, described in the sections that follow.

We used the lesson segment portion of the observation instrument, checking it against the detailed narrative descriptions, to classify each lesson according to its mathematical emphases. We defined mathematical emphasis as the forms of mathematical knowledge and learning that were valued, expected, taught, or made prominent in other ways during the lesson. Table 3 shows the categories assigned to each teacher's lessons. Most of the lessons analyzed fit into one or more of the following categories of mathematical emphasis: (a) technical steps or skills (i.e., a lesson focused on teaching students procedures); (b) work with materials or models (i.e., a lesson in which interaction with concrete or pictorial models was central); (c) meaning, understanding, or strategy development (i.e., a lesson that focused on student understanding of underlying concepts often associated with use of strategies based on these concepts); (d) or student explanation (i.e., a lesson in which students were expected to articulate their understandings to the class or teacher). In addition to reflecting the range of emphases observed in the data, these categories represent a range of mathematics teaching practices discussed in the reform literature. The latter three categories of mathematical emphasis (categories b, c, and d above) figure significantly in the Investigations curriculum. We identified a lesson as having a particular mathematical emphasis if that form of knowledge figured significantly during at least one third of the total lesson. Many lessons had more than one emphasis and were categorized as such. We identified a lesson as having an unclear emphasis when the purpose of the lesson was unclear or there seemed to be a significant mismatch between the tasks and the way they were implemented, as was found by Stein, Grover, and Henningsen (1996). Table 3 also provides the mean duration of lessons for each teacher to provide an approximate measure of the amount of time devoted to mathematics instruction.

We then used interview data and knowledge generated from informal interactions with the teachers to interpret, explain, and check for discrepancies in the patterns that emerged as the data were compiled. In all but two cases, the patterns represented in our data reflected our perceptions of the teachers generated through interviews and informal visits to their classrooms. Both discrepancies involved the level of use of the curriculum as summarized in Table 2. In the first case, Peter Jackson used the curriculum in some form during about half of the observed lessons. However,

³ These three domains of teachers' mathematics curriculum development characterize "the processes by which teachers develop curricular plans and ideals and translate them into classroom events" (Remillard, 1999, p. 316).

Table 3
Summary of Emphases during Observed Lessons

Teacher	Number of times observed	Mean duration of lessons ^a	Emphases for at least 1/3 of the lesson					Comments
			Technical steps or skills	Work with materials or models	Meaning, understanding, strategy development	Student explanation	Emphasis unclear	
Jackson	9	45 min.	4	6	0	0	5	
Reston	10	57 min.	0	10	7	5	3	
Baldwin	27	66 min.	0	10	8	0	14*	*Unclear emphasis was due to weakly structured lessons.
Adler	9	41 min.*	3	5	4	3	0	*Students also worked on mathematics tasks during time in centers.
Kitcher	15	70 min.	1	13	14	7	0	
Schwarz	26	65 min.	3	11	12	5	4	
Graves	8	57 min.	0	6	8	7	0	
Larson	4	55 min.	0	4	4	3	0	

^aThe mean duration of lessons observed should not be interpreted as indicating the amount of time dedicated to mathematics instruction on a daily basis. It was not uncommon for teachers to teach an extended mathematics lesson on a particular day and to skip mathematics entirely the next day. Moreover, it is likely that the teachers spent more time on mathematics when an observer was present.

we are aware from informal conversations with him and visits to his classroom that he used the curriculum much less frequently than half the time over the 2 years. It seems that he tried to use the curriculum when being observed. We are also aware from informal interactions that Zoe Kitcher used the curriculum much more regularly than is represented in her observations.

Finally, we looked for patterns across teachers in the way they used the curriculum in relation to their orientations and the emphases of their lessons. We contrasted patterns in orientation, use, and learning opportunities identified for each teacher. These findings are discussed in the following section.

RESULTS

Our analysis of interviews and classroom observations of the teachers during the first 2 years of using Investigations revealed substantial variation in views they held about the curriculum and in its role in their teaching. Even teachers who viewed themselves as using the materials with fidelity enacted different curricula in their classrooms, and consequently created significantly different learning opportunities for students and for themselves. This tendency corresponds with other research on teachers' uses of curriculum materials (Lloyd, 1999; Remillard, 1999; Sherin & Drake, 2004; Stodolsky, 1989). In order to expand current notions of curriculum materials use, we directed our analysis toward explaining these variations.

We introduce the construct of *orientation toward curriculum* as a critical mediator in the relationship each teacher established with Investigations during this first 2 years of use. We define this orientation as a set of perspectives and dispositions about mathematics, teaching, learning, and curriculum that together influence how a teacher engages and interacts with a particular set of curriculum materials and consequently the curriculum enacted in the classroom and the subsequent opportunities for student and teacher learning. These relationships are represented in Figure 1. As has been documented in other studies of teachers using curriculum resources (Collopy, 2003; Lloyd, 1999; Remillard, 1999), teachers' ideas about mathematics and how it is learned as well as their views about teaching contributed significantly to their use of curriculum materials. Our data reveal that, in addition to these conceptions, teachers' views of the particular curriculum, the extent to which it matched their own ideas about mathematics, and their stance toward curriculum materials in general also mediated their use of the curriculum resource. Furthermore, because this orientation figured in the teacher's use of the curriculum, it played a role in shaping the curriculum enacted in the classroom. The enacted curriculum was also shaped by the beliefs and commitments the teacher held, including the teacher's ideas about mathematics and how it is learned and about teaching and the teacher's role. Finally, because teachers do not implement their plans in a vacuum, but in a classroom with students, the enacted curriculum was also shaped by students' practices. All of these factors mediated the opportunities for teacher learning afforded by particular curriculum materials.

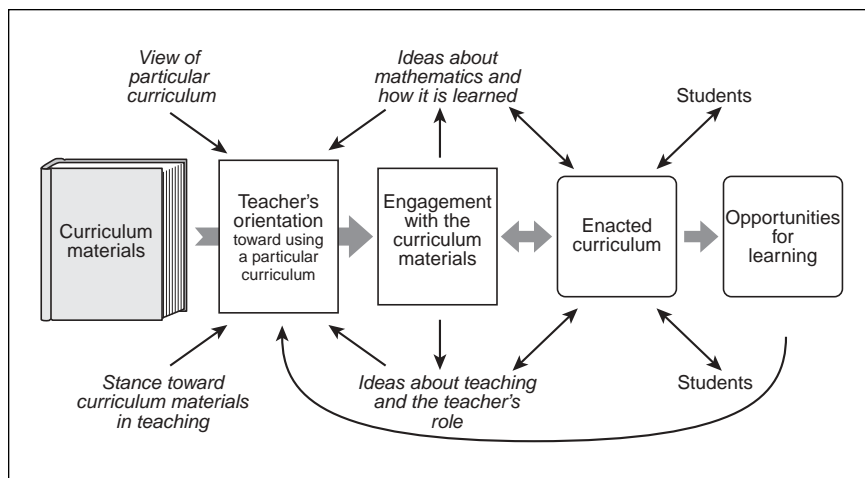


Figure 1. Model of teacher's orientation toward curriculum materials and its relationship to the enacted curriculum.

One caveat we see in this representation (as in other attempts to capture complex relationships) is that the model depicts a linear relationship among teachers' perspectives and beliefs, the use of the curriculum materials, the enacted curriculum, and the consequent opportunities to learn and presents a view of learning that is static. In actuality, we see these relationships as complex and interactive. We also see each of the constructs in these relationships as dynamic. We have endeavored to represent these changes to a limited extent with bidirectional arrows. For example, we found that through the process of enacting curriculum, teachers learned and consequently changed their ideas about mathematics, teaching, and learning.

In the following sections, we use data from the teachers in the study to elaborate the *orientation toward curriculum* construct and the relationship among their orientations, their use of the curriculum, and subsequent opportunities for teacher learning. We begin by describing three contrasting ways of using the Investigations curriculum to illustrate the relevance of the orientation.

Contrasting Orientations Toward and Uses of Investigations

Zoe Kitcher, Peter Jackson, and Kim Reston were all veteran teachers when they first encountered the Investigations curriculum. As a set, they illustrate the significance of orientation toward a curriculum in one's use of it. Two of the teachers, Reston and Kitcher, had similar views about mathematics teaching and learning that seemed compatible with the emphases of the curriculum and that contrasted with those of the third teacher, Jackson. Despite their similar stances on teaching and learning mathematics, Reston and Kitcher used the curriculum in markedly different

ways. In fact, Reston's use of the materials was similar to Jackson's—as a source of activities that they drew on intermittently. Kitcher, on the other hand, used the curriculum consistently and thoroughly. In seeking to understand this apparent conflict, we found that Reston and Jackson had views about the curriculum that led them to take resistant or skeptical stances toward it. In Reston's case, her general mistrust of published materials trumped any potential compatibility between her beliefs about mathematics and those represented in the book. In the following three cases, we describe each teacher's perspectives on mathematics learning, teaching, the role of curriculum materials in teaching, and the Investigations curriculum to illustrate how they contribute to the teacher's orientation toward the curriculum. We also describe the teacher's use of the curriculum to illustrate the relationship between orientation and use. The dimensions for each teacher are summarized in Table 4 along with a unique orientation descriptor for each teacher. The data used to characterize curriculum use are summarized in Table 2.

Zoe Kitcher: Adherent and trusting. Zoe Kitcher began her teaching career in the mid 1970s and had been at Carter Elementary School for 25 years when she began using Investigations. Her views about mathematics teaching and learning were compatible with the curriculum. As shown in Table 4, we labeled her orientation toward the curriculum as both adherent and trusting because she was inclined to follow a guide and placed faith in this particular guide.

Throughout her teaching experience, she maintained a strong commitment to “the open classroom” (10–15–98, Yr. 1)⁴ philosophy that had once been a formal option in the school. During the October 1998 interview she described her views about teaching and learning mathematics and how they developed over her career. She emphasized the importance of conceptual understanding and verbalizing one's knowledge. Her view that mathematics consisted of concepts to be understood was evident in the way she talked about her teaching and her tendency to use curricular resources that complimented this view. For example, she believed that “a good background in place value and number sense” were critical building blocks for third-grade mathematics. She recalled the year when the second-grade teacher devoted significant effort to number sense, grouping, and base-10 concepts: “Well the kids from her class, and I got mostly her class, came and we just zoomed because their understanding was so strong, I mean, it was just an incredible experience for me.” Over 25 years of teaching, she found herself seeking out “teacher's guides that I thought were manipulative-based.” One particular resource stood out to her because “it valued kids' thinking and gave them a chance to articulate their thinking in a way that I hadn't always been able to do.”

Articulating one's thinking was important to Kitcher because she saw verbalizing or explaining in writing as a central vehicle for learning and as an indicator of understanding. When asked to describe a student who was good at mathematics, Kitcher described a child whose “thinking is always right out there, he verbalizes

⁴ This notation represents the date and year that the data were gathered.

Table 4
Summary of Teachers' Orientations Toward the Investigations Curriculum

Teacher	Orientation toward Investigations <i>Teacher was...</i>	Ideas about mathematics and how it is learned	Ideas about teaching and the teacher's role	View of the role of curriculum materials in teaching	View of particular curriculum
Zoe Kitcher	Adherent and trusting	<i>Mathematical emphasis</i> Concepts and understanding through exploration and explanation	<i>Teacher's role is to...</i> Structure exploration and explanation; reduce anxiety	Reliable partner; road map for the whole picture	<i>Saw Investigations as...</i> Philosophical match, supporting views on teaching
Peter Jackson	Quietly resistant	Rules and procedures through direct instruction and practice	Teach rules; prepare students for test; structure activities	Collection of activities and assignments to provide to students	Conflicting with his view of what good teaching is
Kim Reston	Skeptical	Thinking and seeing; building concepts through concrete exploration	Design activities and guide exploration	Limited resource for expanding personal repertoire; not guide	Collection of useful activities to do; similar to own repertoire
Laura Schwarz	Explorative	Understanding of big ideas and connections through exploration and explanation	Learn with students in loosely structured environment	Guide to navigating mathematical terrain	Philosophical match; opportunity for her own math learning
Mary Anne Graves	Piloting	Conceptual understanding and strategy development through exploration and talk	Orchestrate learning through discussion of emergent strategies	Potential guide for sequencing concepts and fostering talk	Philosophical match, although in need of fair test
Myra Larson	Piloting	Conceptual and procedural knowledge through exploration and explanation	Create climate for student exploration, thinking, explanation	Welcome guide to enhance own teaching practices	Philosophical match, supporting deeper understanding
Gloria Adler	Adaptive	Conceptual and procedural knowledge through practice, explicit telling, explanation	Combine direct instruction, exploration, high expectations	Source of activities that foster student learning and thinking	Match with the needs of African American students; adaptable
Selene Baldwin	Activity focused	Practical applications and skills through repetition and problem solving	Provide problem-based tasks in a loosely structured setting	Source of activities for children's projects	Philosophical match; source of tasks and activities

everything, you can almost see it going in and getting processed and then coming back out.”

Kitcher’s ideas about teaching (as summarized in the third column of Table 4) were corollaries to her views of mathematics. In her view, a good mathematics teacher was someone who could “get the richness of writing that explains the child’s thinking.” She also believed it was important to provide learning experiences that made students comfortable and were free of anxiety: “What I want for math time, um . . . to see the kids learning it almost so effortlessly. There is effort for them, but, you know, but without [chuckle] all that anxiety I think that I used to feel.” She was particularly attracted to exploratory activities and games because they made students comfortable and promoted involvement across a wide range of abilities. She liked

Seeing the child who’s, who when you ask something in a very straight setting, you know, with a problem on a page can’t necessarily do it. But then you go to the game format and the child gets it, and realizes that she’s getting something that she didn’t get before.

With respect to her views on curriculum materials, Kitcher was comfortable using curriculum guides. In fact, she relied on them. She said, “I always needed, you know, a teacher’s guide,” but went on to explain that she looked for guides that supported her views of teaching. She found that, even though the Investigations curriculum was unfamiliar and difficult to use at first, it fit with her views of teaching. When asked what resources she used, Kitcher explained that she used Investigations as her primary, but not sole, resource and was surprised to find an overlap between it and a resource she had used previously:

I’m using Investigations and, um . . . before we got Investigations I was using Used Numbers and doing some of those activities. I didn’t know that some of those activities were actually in the Investigations book. That’s fine. Sometimes I’ll pick just from my memory one of the games from Marilyn Burns and do something like that.

By the second year of the study, Kitcher stated, “I’m pretty much following the Investigations curriculum” (9–29–99, Yr. 2). She went on to explain that through using it and attending a summer institute, she developed “a clearer sense of how things fit together and a clearer sense of why we’re doing what we’re doing. So even though I still have some questions, I trust that somehow, it’s in there and it’s being addressed somewhere.”

Indeed, as shown in Table 2, our observations of Kitcher’s use of the curriculum during the first 2 years indicate that she followed the guide closely during 7 of the 15 lessons we observed. We never observed her use an activity from the curriculum without following the related teaching recommendations. During 3 of the 15 lessons, she adapted an activity from the curriculum in order to follow up on student difficulty the previous day. For another 3 lessons, she used a resource that resembled the approach taken by Investigations, following that resource closely to shape the lesson. One of the 15 lessons we observed was designed by Kitcher, a measurement lesson that coordinated with a science unit. Table 3 summarizes the

general emphases of the observed lessons. As the information in that table suggests, Kitcher's observed mathematics lessons tended to focus on developing meaning or reasoning strategies and rarely focused on technical skills. The mean duration of her lessons was 70 minutes. All but one lesson emphasized meaning, understanding, or strategy development. Students worked with materials and models during 13 of the 15 lessons. Only a single lesson focused on technical steps or skills. Student explanation was emphasized during 7 of the 15 lessons observed.

Peter Jackson: Quietly resistant. A teacher with 30 years of experience, Peter Jackson, stands in sharp contrast to Kitcher. Even though he was inclined to use curriculum resources, his views about mathematics teaching and learning and the role of a curriculum guide conflicted with Investigations. Thus, his orientation toward the curriculum, as summarized in Table 4, was somewhat resistant

During the years that the school had both a "traditional" and "open" track, Jackson taught in one of the traditional classrooms. His ideas about mathematics and how and what students needed to learn reflected an instrumental view of mathematics (Skemp, 1978), in that he focused on teaching students computational rules and procedures. He described this mathematical emphasis as being "formal" in contrast to an "informal," or "exploratory" emphasis embraced by other teachers, and he expressed concern that the informal approach did not help all students learn the required material. As he explained in an interview, "Certain students can handle the informal type of situation . . . other students need that structured type of program, because if you allow them to work by themselves, they won't get anything done" (11-28-98, Yr. 1). Jackson also expressed concern that it was not enough for students to know how to explain their answers, "they have to actually do the computation part of the problem" (2-3-00, Yr. 2).

Jackson viewed his own mathematics teaching as a "mix of informal and formal" practices depending on the situation (11-28-98, Yr. 1). And he stated that he thought developing thinking, explanation, and problem solving were important. His teaching decisions appeared to be highly test-driven, more so than any other teacher in the study. He referred to the standardized test in every interview, often citing it to explain his choice to focus on a particular computational skill in a lesson. In the following quote, however, he used the emphasis on explanation on the test to justify why students needed to learn to explain their answers:

I'd like for them to be able to explain how they got the answers instead of just writing down the answers. Mathematical thinking should play a really important role in their learning how to do math. They must know how to explain how'd you come up with that particular answer and be able to write it out, especially when they take the SAT 9. There happens to be open ended type questions on those tests (11-28-98, Yr. 1).

Like Kitcher, Jackson appeared to be comfortable using a curriculum guide or textbook. In both years of the study, he distributed commercially published mathematics textbooks to his students and used them during mathematics lessons and for homework. In interviews, Jackson never voiced direct opposition to the approach taken in the Investigations curriculum, although he periodically noted that students

needed to know particular procedural skills for the standardized test and indicated that he needed to supplement the curriculum to teach them. We interpreted these remarks, together with his limited use of the curriculum, as reflecting a conflict between his ideas of good mathematics teaching and the curriculum. However, because he never vocalized opposition, we have identified his orientation toward the curriculum as *quietly resistant*.

As is indicated in Table 2, we observed Jackson's mathematics teaching 9 times over the 2 years. During this time, he never used the curriculum to guide the flow of the lesson. In 4 of the 9 observed lessons, Jackson used an activity from the curriculum, but introduced and structured it quite differently from the manner suggested in the curriculum. Most often, the activity he selected centered around a student worksheet. During 3 of the observed lessons, Jackson used the commercially published textbook that he had distributed at the beginning of the year and from which he assigned homework regularly. Through informal interactions with and observations of Jackson, we are aware that he used the commercially published curriculum as his primary text, although he often made a special effort to use Investigations when being observed formally. He introduced the curriculum to his fourth-grade students for the first time on November 28, 1998, the second time that he was observed. He began the 38-minute lesson by saying:

What we're going to be doing for the next few weeks, boys and girls, is going to be using a new program called "Investigations in Mathematics." We'll be using different tools, for example calculators, . . . we'll be using interlocking cubes that go together, and various other kinds of tools that can be used. In mathematics we use different types of tools to solve the math problems, and math helps you to think about solving different types of problems.

The lesson was drawn from the first book in the series, *Mathematical Thinking in 4th Grade*, and was titled "Getting Started with Interlocking Cubes." For this lesson, the curriculum guide suggested that every student, individually or in pairs, build an object out of interlocking cubes and then estimate the number of cubes used in the figures made by each of the other students in the group. Students were then to count the actual number of cubes, recording both the estimated and actual amounts. The lesson outline included time for conversation about making estimations and suggested that students be encouraged to work together using the information they gleaned from the first estimate and count to make increasingly more accurate estimations. The curriculum guide included a prepared page containing a table for students to use when recording their estimates and as well as questions that ask the students to share estimating strategies with others. The guide also provided some sample dialogue to help the teacher imagine the kinds of conversations students might have about estimation strategies.

Jackson began the lesson by giving the students 10 minutes to "mess around with the cubes." He then instructed the students to make a figure with the cubes and gave them 15 minutes to do so. The students' desks were arranged in groups of six and he gave students 5 minutes to circulate the figures among the students in each group so they could estimate the number of cubes used to make the figure. In explaining

what he meant by estimate, Jackson said, “Estimating means that you’re going to make a guess to find out how many cubes are in that individual shape.” He instructed them to write their guesses on a note card that circulated with the figure and periodically discouraged students from talking during this exercise. At one point, when Jackson spotted a pair of students talking about their cube structures, he admonished them to “Do your own work.” For the last 8 minutes of the lesson, Jackson had the students answer the questions on a student worksheet provided by the curriculum. The questions asked students to describe how they estimated and to tell how they would advise another student about how to estimate the number of cubes in a figure. After 8 minutes, Jackson closed the lesson by saying, “We started talking today about estimation. We used the cubes and counted how many cubes were in a particular figure. Tomorrow we’re going to continue this. Right now, make sure your name is on the paper and hand it in” (Observation 11–28–98, Yr. 1).

This lesson is illustrative of the way that Jackson used the curriculum to find tasks to give his students. Although the activity was drawn from the Investigations book, Jackson did not use the suggestions in the book to facilitate students’ work on the task. For example, he equated estimation with guessing and did not attend to estimation strategies to assess or build students’ number sense; nor did he ask students to explain their reasoning or discuss their guesses with their classmates. The emphasis he placed on doing one’s own work reflected his well established teaching routines and beliefs about student learning.

During all of our observations of Jackson over 2 years, we never observed him focus the emphasis of the lesson on strategy development or ask students to provide explanations for their approaches even when using the Investigations curriculum. As Table 3 illustrates for Jackson, his lessons tended to be about 45 minutes long and 4 of the 9 lessons observed focused on technical skills or steps. For the other lessons, the emphasis was unclear. During these lessons, Jackson led the students through an activity from Investigations that had the potential to emphasize meaning, understanding, or strategy development. However, he tended to avoid the parts of the lessons that focused on underlying meanings or explanation.

Kim Reston: Skeptical. Kim Reston, an experienced teacher of 30 years, 26 of which had been at Carter, offers a contrast in orientation to both these teachers. As a teacher, she was independent, confident, and opinionated and was skeptical of published programs and curricula, even when they were based on views similar to her own. She originally taught in an open classroom and adhered strongly to ideals of progressive education. She described her views and experiences during her first interview on September 9, 1998; they are summarized in Table 4. She viewed mathematics as a way of thinking and seeing: “being able to imagine, to see it in their heads.” She felt it was important for students to explore ideas and build a conceptual base before being introduced to procedural rules. “Most often,” she explained in an interview, “they’ve [rules] been taught too early, so that they [students] don’t have a connection between the abstraction and the—they don’t get the concept of numbers yet, but they have all these notions about the rules.” She also wanted students to see mathematics in the world around them—to “see how much number,

how much math there is in the world to give them a really rich experience related within math, like geometry and game playing strategy games stuff like that.”

Over the years, Reston had developed a mathematical teaching repertoire that she felt comfortable with and that provided her first-grade students with the concrete experiences she believed they needed. Her repertoire grew out of a number of programs and materials that focused on conceptual development and became available in the 1960s and 1970s, which she pursued on her own:

I always had an interest in math, a different interest than . . . , you know, kind of an idea interest in math, and I read some books and for a while I was involved in some workshops through the Educational Development Corporation [*sic*], the Cuisenaire, Madeline Gituard. I did a lot of that and just my own interest. And Madison Math. All history that has been lost unfortunately, but were very interesting math initiatives, and I did a lot of work based on the Nuffield math series (9–9–98, Yr. 1).

Like many teachers who developed progressive practices in the 1970s and maintained them through the back-to-basics era of the 1980s, Kim was skeptical about packaged curriculum materials or any instructional approach that was not teacher-constructed. Her repertoire had been developed through her own studies and explorations and she was disinclined to accept a curriculum wholesale. Moreover, even though the curriculum fit with her ideas about teaching mathematics, she did not see Investigations as offering much new. When describing the games in the curriculum, she said, “I think maybe there are several more of them than I’ve had before, but no, it’s not necessarily new. Some of the games are very much similar to other games that I’ve had before” (3–25–99, Yr. 1). Later in the same interview, when asked about the emphasis on student dialogue in the curriculum, Reston stated somewhat defensively, “I don’t find that an unusual thing, we do that anyway. . . . I really don’t know what I am doing in Investigations that is separate from what I’m doing in something else.”

Like other curriculum resources she used, she saw Investigation as:

Just a really interesting way of having kids approach something and being able to experience something and have a mathematical experience. . . . I don’t know if it’s necessarily a curriculum, but it has a whole bunch of things that were very useful to do within a loose framework with having kids manipulate (3–25–99, Yr. 1).

Reston’s view of the Investigations curriculum as “not a curriculum” seemed related to her skepticism about the usefulness of packaged curriculum and to her identity as a teacher who did not follow a set curriculum. We labeled her orientation toward Investigations as skeptical because of the doubt she expressed that it offered her anything new. She used the Investigations curriculum similarly to the way she used other resources. She periodically drew individual activities from the teacher’s guides. The tasks she selected were those that were similar to activities she already used or that meshed with other topics in her curriculum. For example, she used a number composition task from Investigations that was already part of her routine. She also attempted to draw geometric tasks from one of the Investigations units that she thought would connect to a quilting study from her social studies curriculum. Reston tended to avoid tasks that were new to her unless

she saw them demonstrated elsewhere. Like other teachers, she occasionally brought the mathematical activities from the research project's study-group meetings to her students.

As is indicated in Table 2, Reston drew on Investigations during half of the 10 lessons we observed, but she never used the curriculum to guide the flow of the lesson. She used an activity from Investigations three times and adapted an activity from the curriculum twice, but used her own plans to introduce them and support students' work. We also observed her use of other resources three times and an activity that she designed as a follow-up to an activity from Investigations once.

In describing her approach near the end of the 1st year of using the curriculum, Reston said:

I use a lot of Math Their Way, that has been, um and I use that pretty systematically to go through numbers, but then it has been very useful to supplement it with some of the worksheets and some of the activities that are in Investigations, and I've been jumping around from to different books. One I haven't done much of, but I want to is the one on quilts, because we've been I can make that relevant to what we're doing—we've been doing story quilts and it would work thematically (3–25–99, Yr. 1).

It was apparent from our interview and observations that Reston had spent little time reading the Investigations books. Rather, she skimmed them briefly and chose activities that fit with her repertoire. Midway through the 2nd year of the study, an interviewer asked Reston to describe what she had been doing in mathematics. After describing a set of activities, she explained, "I'm not sure that's in Investigations. I just . . . that's part of the old stuff I was doing, but . . . it really is very consistent with it. It's not any different" (2–22–00, Yr. 2).

The Significance of Orientation Toward Curriculum

What we found most striking when comparing these three teachers' uses of the curriculum is that, despite their dramatically differing views about mathematics, teaching, and the curriculum, both Reston and Jackson used Investigations in similar ways; it was a source of activities that they drew on intermittently. Moreover, despite their similar stances on mathematics, teaching, and learning, Reston's and Kitcher's uses of the materials were markedly different. These cases illustrate the significance and complexity of the teacher's *orientation toward curriculum*. Although a philosophical match with the curriculum was important to how a teacher used the curriculum, so was the teacher's stance toward curricular resources in general. As we examined the orientations of all the teachers in the study, we found that the stances they took toward the Investigations curriculum and the way they used it were closely connected to how they conceptualized curriculum resources in teaching. The orientations of all the teachers in the study are summarized in Table 4. In addition to Kitcher, Laura Schwarz, Mary Anne Graves, and Myra Larson viewed curriculum materials as a potential guide in one's teaching. Their orientations toward Investigations, although somewhat varied, all reflected openness to thorough use. Gloria Adler and Selene Baldwin, on the other hand, both viewed

curriculum as a source of activities to be used in and adapted for one's instruction. Their orientations reflect a focus on selective use of the curriculum.

In the following sections, we discuss patterns observed in the teachers' uses of Investigations in relation to their individual orientations toward the curriculum. We then characterize and analyze the kinds of opportunities for learning that the teachers made available for themselves through their use of Investigations.

Teachers' Use of Investigations in the Classroom

As described earlier, we looked at three central domains of teaching to analyze teachers' uses of Investigations: (a) curriculum mapping, or the structure of the entire curriculum; (b) curriculum design, or the tasks that the teachers selected, adapted, or designed; and (c) enacted curriculum, or how they enacted the tasks in the classroom (Remillard, 1999). Using patterns represented in Table 2 and the interview data, we characterized the role the curriculum played in each domain of each teacher's practice. We used these patterns to identify three broad categories of use: *intermittent and narrow*, *adopting and adapting tasks*, and *thorough piloting*. For the 8 teachers, these categories remained relatively stable for much of the first 2 years they used the curriculum. As we explain later, we observed some changes in two of the teachers' uses of the materials by the end of the 2nd year. As shown in Table 5, we grouped the teachers according to these three categories of use to highlight the patterns we observed in their uses of Investigations across the three domains. As we discuss below, we found similarities in orientation among teachers in each category.

Intermittent and narrow use. As we described earlier, Reston and Jackson used Investigations intermittently during the first 2 years of the study. However, if we think of these categories as a continuum of use, Jackson would be much closer to the "no use" end than Reston. Both teachers, however, used the materials minimally, primarily relying on their own teaching routines and other resources to guide their curriculum map over the year. When they did use Investigations, both tended to use the resource narrowly—selecting familiar tasks and using the repertoires they had developed over years of teaching when enacting them in the classroom.

Adopting and adapting. The second category of use includes the teachers who used the materials as a guide for the general structure and content of their mathematics curriculum, that is, what topics to teach and how to sequence them, as well as many of the tasks they presented students to work on. The two teachers in this group, Gloria Adler and Selene Baldwin, regularly adopted mathematical tasks from the curriculum guides, but drew on their own strategies and approaches to enact them in the classroom. In other words, they adapted them to fit their familiar approaches to teaching. On some occasions, their enacted lessons looked similar to the suggestions in the teacher's guide; other times, particularly in Baldwin's case, we saw little resemblance between the lesson and the suggestions in the guide. For both teachers, this approach to using the curriculum materials reflected their views about mathematics and how it is learned and about the role of curriculum resources in teaching.

Table 5
Summary of Teachers' Use of the Investigations Curriculum

Categories of use	Teacher	Curriculum mapping (Determining mathematical topics, sequencing, and timing)	Curriculum design (Selecting and designing tasks given to students)	Enacted curriculum (Enacting tasks in the classroom)
Intermittent and narrow	Peter Jackson	Used Investigations primarily when observed. Followed own curriculum map.	Selected task that involved independent work.	Developed own plan for enacting tasks.
	Kim Reston	Followed own curriculum map.	Selected tasks with which she was familiar and comfortable.	Introduced and implemented activities in her own way.
Adopting and adapting	Selene Baldwin	Allowed Investigations to guide general structure of math curriculum.	Selected specific skills and activities from guides.	Developed own plan and timing for enacting tasks.
	Gloria Adler	Allowed Investigations to guide general structure of math curriculum.	Selected specific skills and activities from guides.	Used direct instruction to introduce and reinforce student work on Investigations tasks.
Thorough piloting	Zoe Kitcher	Allowed Investigations to guide general structure of math curriculum.	Followed suggestions in guide to design lessons; read suggestions in teachers' guide thoroughly.	Closely followed curriculum guides when implementing plans.
	Laura Schwarz	Allowed Investigations to guide structure of math curriculum; followed each unit but devoted additional time to lessons.	Followed suggestions in guide to design entire lessons.	Followed curriculum guide to initiate lesson, but frequently led off track by mathematical diversions or confusion.
	Mary Anne Graves	Allowed Investigations to guide general structure of math curriculum.	Followed suggestions in guide to design lessons; read suggestions in teachers' guide thoroughly.	Followed curriculum guides when implementing plans.
	Myra Larson	Allowed Investigations to guide general structure of math curriculum, but incorporated other activities into it.	When using Investigations, followed curriculum guides with care.	Followed curriculum guides when implementing plans.

Both placed considerable emphasis on the role of activities or tasks in mathematics teaching and saw curriculum as a source of such tasks.

As Table 4 indicates, Gloria Adler believed that as a teacher of African American students she needed to attend to both conceptual and procedural knowledge. “You need to empower children,” she asserted in an interview. She went on to explain that children needed to become “comfortable with numbers.” They needed to understand mathematical concepts, solve problems, and explain their thinking. But, “there’s a need for memorization. Memorization doesn’t explain anything, you know, but there are some things that just need to be automatic for you. . . . Also, terminology. I think terminology’s important for children to understand” (2–3–00, Yr. 2). She liked Investigations because she believed it supported her ideas about “student-centered exploration” and attended to student thinking while being amenable to explicit teaching. She also liked the emphasis the curriculum placed on explaining one’s thinking. We labeled her orientation toward Investigations as *adaptive* because she was inclined to use the curriculum, but modified its suggestions and guidance to fit her views of what her students needed. The following descriptions from Adler’s teaching illustrate her tendency to embrace the elements of the curriculum that supported her views and adapt others to make them fit, while disregarding aspects that she did not value.

Adler organized much of her teaching around six mathematics learning centers. In groups of 5 or 6, her 26 second-grade students rotated through two or three of the centers each day. She used the learning centers for students to extend or continue the work that they did during whole-class lessons, which she tried to keep short to allow for daily center time. She viewed curriculum as a source of activities that she could adapt to suit this structure. Adler frequently found portions of Investigations lessons that involved individual or group work and set them up in the mathematics learning centers. Of the 10 lessons we observed, she used the curriculum to guide the lesson only once, the first time she was observed. As shown in Table 2, for 5 lessons, Adler used or adapted tasks from the curriculum guide to construct shorter lessons and then assigned related tasks to be completed in the centers. Four of the lessons we observed in Adler’s class were drawn from other resources or her own design. Two of these lessons focused on preparation for the upcoming standardized test, and the other two focused on teaching the conventional algorithm for subtraction.

When working with the whole class, Adler used direct instruction strategies and gave great attention to terminology that was not included in the curriculum guide. During one lesson on making combinations that summed to 10, Adler inserted the term “addends” into the students’ work on the activity from Investigations. “Now when I say ‘addends,’ does that mean you can subtract? No. If I say two addends that make the sum of 10, what do you have to do? You have to plus, you have to add it” (Observation 11–17–99, Yr. 2). Adler, however, did not stop at developing correct procedures. As shown in Table 3 in about half of the lessons we observed, she emphasized underlying meanings or strategy development and she placed some emphasis on explanation during a third of the lessons observed, requiring students to write down how they solved the assigned problem in addition to the solution.

These examples illustrate Adler's frequent adopting of mathematical tasks and some pedagogical strategies, such as written explanation, suggested in Investigations. They also demonstrate her selective and adaptive use of such pedagogical strategies and her tendency to integrate these activities into her pedagogical repertoire.

Selene Baldwin demonstrated a similar orientation and tendency in her use of Investigations. Like Adler, she was intrigued by many of the problem-solving tasks in the curriculum as it fit with emphases she had been developing in her teaching:

I like the process of helping kids get to the point of figuring out things on their own. . . . I did what's called the problem of the day last year, and my kids really enjoyed it. A problem is presented and you read the directions, told them what to, you didn't specifically tell them how to solve it, but whatever ways they came up with to solve it, all they had to do was justify why they had thought or believed or written whatever they wrote (10-8-98, Yr. 1).

We labeled her orientation toward Investigations as *activity focused*, because she saw the curriculum as a source of interesting activities to give students. As an *adopter and adapter* in her use of the curriculum, Baldwin took advantage of many of the open-ended, problem-based activities suggested in the guides. Even though the curriculum materials offer substantial guidance for the teacher on helping students develop problem-solving strategies and articulate their thinking, we did not observe Baldwin using these suggestions. Instead, she tended to present students with a problem, repeating it multiple times, but did not provide them with support in interpreting and approaching the problem. On several occasions, it appeared that she was reading the explanation of a particular task in the curriculum guide for the first time as she introduced it to her students. This tendency to glance at the curriculum book periodically for guidance while teaching was reminiscent of the way many commercially published teacher's guides are intended to be used. In this way, Baldwin appeared to draw on her past experience using mathematics textbooks in using Investigations.

Thorough piloting. Four of the teachers in the study, Zoe Kitcher, Laura Schwarz, Mary Anne Graves, and Myra Larson, tended to read and use all parts of the curriculum guides in their teaching. These teachers used Investigations as their primary guide in teaching mathematics from structuring the curriculum to selecting tasks to facilitating students' work on those tasks. To differing extents, each teacher used activities and strategies from other sources including their personal repertoires. However, when using the Investigations curriculum, they sought to follow the lessons as suggested in the guide, studying, and sometimes struggling with, all or most of the information provided for the teacher. Hence, we categorized these teachers as engaging in through piloting of the Investigations curriculum.

As Table 4 indicates, all of these teachers held similar beliefs about mathematics, learning, and teaching, which matched philosophically with the Investigations curriculum. However, the most significant factor in shaping their orientations

toward this particular curriculum was their shared ideas about the role of curriculum materials in teaching. They all tended to view curriculum resources as guides or partners in their teaching and, for differing reasons, they were all committed to getting to know the curriculum fully or giving it a fair trial. As described earlier, Kitcher preferred to have a guide to follow and because she agreed with the approach taken in by Investigations, her stance was *adherent* and *trusting*. Schwarz, on the other hand, new to teaching and intent on exploring the mathematical ideas along with her students, saw the curriculum as a guide in these explorations. We labeled her orientation as *explorative*. Graves and Larson had the most similar stances toward curriculum as a tool. Both had fairly developed ideas about their goals for teaching mathematics, which included emphasizing strategy development and student explanation, but little experience enacting them. They viewed curriculum materials as a possible source of guidance in attending to these goals. We identified their orientations as *piloting* because they saw themselves as trying the curriculum out. Graves was particularly clear about this provisional stance. She explained, “I don’t believe I can express an opinion about it until I have used it as the authors intended” (2–25–00, Yr. 2).

An important similarity among these four teachers’ ideas about mathematics learning and, subsequently, the role of the teacher is the emphasis on student thinking and talk about mathematical ideas. This commitment was also reflected in their views that a curriculum might help them foster these practices amongst students. In other words, they viewed curriculum materials as a resource for them and not just a source of activities for students. This pattern stands in contrast to the orientations of the other four teachers and was reflected in their close use of the curriculum. Even though Adler and Reston placed some emphasis on talk or explanation in their views about mathematics learning, neither saw curriculum materials as a source of guidance for the teacher in fostering these practices.

As is noted in Table 2, these four teachers used Investigations to guide the flow of their mathematics lessons during at least half the observed lessons. Kitcher and Schwarz used the curriculum thoroughly during 7 of 15 and 13 of 26 observed lessons, respectively. Graves and Larson used the curriculum in this way for a greater proportion of lessons—6 of 8 and 4 of 4, respectively. It is also worth noting that these four teachers rarely adopted activities from the curriculum without using the guide to structure the class work on the task. It is also worth noting, as shown in Table 3, that these teachers taught lessons that emphasized meaning, understanding, or strategy development as well as explanation substantially more often than the other four teachers. Because these emphases are found throughout the Investigations curriculum, it is possible that the extent of these emphases resulted from close use of the curriculum.

Three of the four teachers in this group had the least teaching experience in the study. Schwarz, Graves, and Larson were all in their 3rd or 4th years of teaching when they began using Investigations. Unlike the five experienced teachers who appeared to have well-established routines in their practices, these new teachers had little experience teaching mathematics at all. All three teachers made it clear that

they appreciated the structure that a curriculum guide offered, even though managing the new materials was overwhelming at times. Schwarz reported, "I don't have something I'm replacing with this new unit [Investigations]. This new unit is still providing me with my basic stuff" (9–30–98, Yr. 1).

It is important to note that the Investigations curriculum is not scripted. Thus, following it in great detail involved careful thought and decision making for these teachers. Not only are teachers encouraged to make adjustments to fit the interests of their particular students, but in the course of any lesson, teachers find themselves making a number of on-the-spot decisions (Heaton, 2000; Remillard, 1999). For example, the guides suggest what ideas or understandings teachers should emphasize or look for during a discussion, but do not and cannot guide the teacher through each step of the discussion. Still, the teachers in this group found themselves exploring practices, struggling with mathematics, and confronting student thinking in ways that were unfamiliar. Thus, their particular approach to using the Investigations curriculum established opportunities for learning that were not available to the other teachers. We discuss our analyses of these opportunities in the following sections.

Opportunities for Teacher Learning

In order to explore how this Standards-based curriculum might foster teacher learning, we examined the opportunities to learn created by the teachers' use of the materials. We define opportunities for learning as events or activities that are likely to unsettle or expand teachers' existing ideas and practices by presenting them with new insights or experiences (Ball, 1994; Bruner, 1960/1977). We examined opportunities generated through reading the curriculum materials, planning instruction, and the process of enacting curriculum in the classroom.

In this section, we identify patterns observed in the opportunities that teachers created for themselves to learn more about mathematics, teaching mathematics, and student thinking. The opportunities that we uncovered ranged from what happened when teachers' read and discussed summaries of research offered in the curriculum guides to teachers' explorations of mathematical ideas with students to their efforts to make sense of student thinking. By focusing on the opportunities for learning, we are not, at this point, making claims about *what* the teachers have learned after using Investigations for 2 years. Rather, we looked at the potential for learning, given their interactions with the curriculum. Our assessment of potential for learning, however, is influenced by our preliminary findings about teacher learning, as well as related research (Collopy, 2003; Remillard, 2000).

In our effort to uncover relationships among teachers' orientations, their use of the curriculum materials, and the opportunities for learning, we focused on those opportunities most prominent in their interactions with the curriculum. We believe that structured activities designed to support teacher learning, such as the study group associated with this research project, are critical in providing opportunities for teacher learning. However, because of our focus on learning from

curriculum materials, we do not include opportunities made available through these events in our analysis for this article. We anticipate that our findings will inform the format and content of these activities. At the same time, we also assume that teachers' experiences in the study group have an impact on their ideas and perspectives that, in turn, affect their orientations toward the curriculum materials and use of them.

Our analysis of classroom observations, interviews with teachers, and conversations during the study group suggests that the varied approaches to using the Investigations curriculum led to different opportunities for learning. Four categories of opportunities emerged from our analysis: (a) expanding one's repertoire of activities; (b) insights into student thinking; (c) explorations of mathematics; and (d) constructing the teacher's role in orchestrating student learning. Although we see each of these opportunities for teacher learning as distinct in nature, some are closely related to one another. For this reason, we place teachers in these categories as illustrations of the categories themselves and of the correlation we found between the teachers' use of the curriculum materials and their opportunities for learning. We discuss each below, but first mention the two teachers whose limited use of the curriculum resulted in very few opportunities for learning.

Minimal engagement in learning. Despite their different orientations to curriculum, Jackson and Reston used Investigations intermittently and narrowly and thus created few opportunities for their own growth through their interactions with it. Jackson, who maintained a resistant stance toward the curriculum, participated minimally in the study group and seemed bound by his existing ideas about mathematics and teaching. As the lesson described earlier illustrates, when he did use the curriculum, he did so only nominally by selecting tasks that he integrated into his own pedagogical practices and essentially disregarding reform-oriented suggestions. Thus, his use of Investigations provided him with few opportunities to learn about students' thinking, explore unfamiliar mathematical ideas, or consider alternatives approaches to teaching.

Reston's intermittent use of Investigations reflected her skeptical stance toward packaged curriculum materials, regardless of how closely they fit her progressive philosophy. Her inclination was to select tasks that felt familiar to her without taking the time to study the curriculum in detail, leading to minimal engagement with the materials. However, over the 2 years, Reston's intermittent selection of activities increased in frequency. As indicated in the following section, her opportunities for learning increased with her engagement of the materials.

Expanding one's repertoire of activities. The teachers who tended to use the Investigations curriculum by consistently adopting tasks that they integrated into their own pedagogical practices created opportunities for learning that were similar to one another. Adler and Baldwin, as well as Reston during the latter period of data collection, found themselves exploring new mathematical tasks to pose to students. Their use of the curriculum provided them with an array of new activities, but limited opportunities to expand their ideas about the teacher's role in fostering learning from

these activities. Like Reston, however, Adler's use of Investigations changed over the period of data collection. In addition to adopting problems to present to students, in her 2nd year, Adler began to follow suggestions in the teacher's guide that asked students to explain their work. Her emphasis on clarity in students' work, prominent in the 2nd year, led her to pay close attention to their explanations, probing for details. As discussed in the next section, Adler's latter use of the curriculum also led to opportunities for her to learn about student thinking.

Insights into student thinking. As noted above, Adler's increasing use of student explanation and her tendency to probe their thinking and try to make sense of their ideas provided her with opportunities to learn more about her students. As she put it, "Investigations does give you the opportunity to be able to sit down with somebody and . . . have time to go and see how does this person count and are they using the manipulatives, doing it in their head." (2-23-00, Yr. 2). The other teachers whose use of Investigations provided them with opportunities to gain insights into student thinking (Graves and Larson) were those who we categorized as *thorough pilots* of the curriculum. Graves and Larson were also intrigued by the emphasis on student talk and explanation in the curriculum. They followed suggestions in the teacher's guides to encourage students to explain their thinking, which provided them with many opportunities to learn about student thinking. Larson talked about the way the curriculum guided her to focus on students' thinking process. In an interview, she recalled asking a student to explain her drawing: "I wondered did she really understand, and then she sat down and explained it all to me. Her words matched her picture. It was wonderful. I'm like, you really understand!" (3-23-99, Yr. 1). Graves, in fact, was deliberate about this learning as she planned to guide her interactions with students: "Investigations builds in a lot of time for us to be taking one-on-one records . . . what I would like to be able to do from that kind of information is then customize the way that I talk about math with individual students" (10-7-99, Yr. 2).

Constructing the teacher's role in orchestrating student learning. Graves' desire to use what she learned about student thinking to inform the way she talked with individual students hints at another opportunity for learning we saw available to some teachers who were *thorough pilots* of the curriculum. As they learned more about student thinking, Graves and Larson found themselves needing to respond to these diverse and unanticipated ideas. This process itself provided these two teachers with opportunities to learn about the teacher's role in orchestrating student learning. Not only did they read the guiding suggestions and background information in the curriculum, but also they found themselves constructing new practices on the spot.

This kind of opportunity to learn is illustrated by a brief interaction in Larson's first-grade class in February 1999. She began an introductory session on grouping by showing the students an arrangement of squares as depicted in Figure 2. "What's up there?" she asked. A student replied, "Some squares stuck together, some by themselves." After soliciting a few more descriptions, Larson asked, "How many

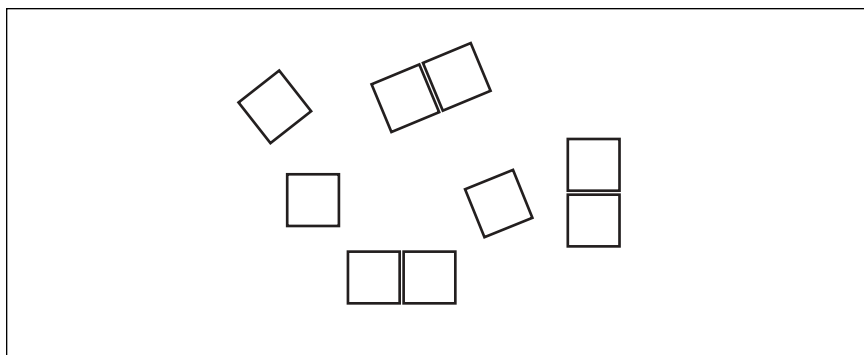


Figure 2. The arrangement of squares shown by Larson to her first-grade class.

squares are up there?” The student she called on said, “Three.” Larson hesitated. She had anticipated the answer “nine,” so that she could then ask students to show how they counted the nine squares, as the teacher’s guide suggested. At that moment, Larson needed to figure out how to help the students consider whether the “squares stuck together” might also be counted as squares. Later Larson said that the students’ observation made sense, but “wasn’t what I expected” (2–24–99, Yr. 1). Larson recalled thinking quickly about how to help this and other students consider alternative interpretations. This sort of thinking on one’s feet provides considerable opportunities for learning about how to orchestrate student learning (Remillard, 2000).

Explorations of mathematics. Three of the teachers who we categorized as thorough pilots of the curriculum placed substantial emphasis on exploring the mathematical ideas embedded in the units and in gaining a clearer understanding of the mathematics curriculum. Two of the teachers, Schwarz and Larson, despite substantially different mathematical backgrounds, used their work with Investigations as an opportunity to extend their mathematical knowledge. As they facilitated their students’ work on the mathematical tasks in the curriculum, they found themselves contemplating and often struggling with the underlying concepts. Larson, who studied formal mathematics in college, found herself developing a new understanding of mathematics that put her formal studies in a new light. Schwarz, who lacked confidence in her mathematical ability but was anxious to learn more, described herself as enjoying the “puzzle and game” aspect of mathematics. In her mathematical explorations with her students, she saw herself as “a detective . . . go[ing] after the unknown.” Schwarz reported that teaching mathematics with the Investigations curriculum had shown her “the deeper thinking that I still have never . . . still have little experience articulating. . . . It is the real way mathematics is done” (9–30–98, Yr. 1).

Kitcher's explorations of mathematics through her use of Investigations focused on expanding her understanding of how mathematical ideas are related to one another and how they add up to something whole. She often talked about "getting a sense of the whole curriculum and the underpinning ideas" (9–29–99, Yr. 2). In an interview, she described her experience watching students work on a task that built on ideas the class had explored earlier in the year: "I think that was a breakthrough for me of understanding how this was just a piece of something larger" (5–02–00, Yr. 2).

CURRICULUM MATERIALS AS A VEHICLE TO SUPPORT TEACHER LEARNING

We began our study of these 8 teachers seeking to understand the ways in which Standards-based curriculum materials might support teacher learning, or as Bruner (1960/1977) put it, be "a curriculum for teachers" (p. xv). However, our research illustrates how multilayered and complex the relationship is between teachers and curriculum materials. By considering the factors contributing to different uses of the materials we observed, we were able to shed light on the role that teachers' orientations toward the particular curriculum materials played in their use of it and in subsequent opportunities for learning. In short, we see a teacher's orientations toward a curriculum as a frame that influences how he or she engages the materials and uses them in teaching. This orientation is not only influenced by the teacher's beliefs about mathematics teaching and learning, but also reflects the teacher's view of curriculum materials, in general, as well as the particular curriculum. Because this orientation figures in the teacher's use of the curriculum, it plays a role in shaping the opportunities to learn available to the teacher. The fact that teachers' views of curriculum materials in general contributed to their orientation indicates that, at least for some teachers, the form of the message is as powerful as the message itself. The significance of teachers' orientation toward a curriculum is illustrated particularly well by Reston and Jackson, whose similar orientations led to similar kinds of use and opportunities for learning despite substantially different views about mathematics teaching and learning.

Although the focus of our research was on how using Standards-based curriculum materials might provide opportunities for teacher learning, we are not suggesting that this type of learning does or should happen in isolation. As is typical of many teachers, these teachers participated in a variety of formal professional development opportunities and informal conversations about the materials. In particular, they attended a monthly study-group meeting, and they had regular conversations with project researchers. It is evident that these interactions created opportunities for learning that were not directly related to teachers' use of the curriculum. In fact, during interviews, many teachers claimed that conversations with colleagues about the materials helped them to understand where the curriculum was headed across the grades. They also indicated that doing mathematical tasks from the curriculum with others and listening to how other adults, including university researchers,

approached problems helped them to understand the purpose of many of the activities suggested in the curriculum guide. Nevertheless, we sought to focus our examination of opportunities for learning on teachers' experiences using the curriculum materials, while acknowledging that these other experiences necessarily contributed to the teachers' orientations toward the curriculum, their uses of it, and the subsequent opportunities for learning made available through their use.

Our analysis of teachers' orientations toward curriculum materials and their relationship to teacher learning reveals the power that teachers have in shaping their own learning experiences even unintentionally. Through the particular ways the teachers read and used the Investigations curriculum, they generated individualized learning opportunities. While we did find relationships between particular tendencies in use and opportunities to learn, the variation among teachers is significant because it suggests different learning trajectories across teachers using the same materials. Although it seems safe to assume that the school-wide adoption of a set of curriculum materials can serve to unify the work of a group of teachers around a particular set of ideas and experiences, our findings suggest that teachers' experiences with the same resource were highly diverse.

An important dimension of the individualized ways in which teachers used curriculum materials is the diversity in how and what they read. The teachers we studied read and used different parts of the materials. Most significantly, only 4 of the 8 teachers read the material written for teachers. This variation has been seen in other studies of teachers using reform-oriented materials (Collopy, 2003; Sherin & Drake, 2004). The differences in teachers' reading of curriculum guides documented in these studies are particularly noteworthy since many Standards-based materials provide information directed at the teacher. Experienced teachers seem to develop pedagogical repertoires that include the ways they read and use curriculum resources. It is likely that the repertoires many teachers established around textbook use reflected the nature of the resources available. For years, commercially published teachers' guides consisted of tasks to give students along with little or no guidance in how to introduce these tasks (Remillard, 1996). These texts were designed for teachers to pick up and use with minimal preparation. Even though Standards-based curriculum materials are designed to be read by teachers ahead of time, it appears that teachers' stances toward curriculum materials figure into how they read materials that are significantly different from those they are familiar with. For example, when using the curriculum guides, four of the teachers in our study tended to look for activities to give students without reading the related information for teachers. This finding raises questions about the power of curriculum materials to speak to teaching absent from other supports or interventions. One component of learning required of teachers to teach mathematics for understanding might involve learning to read and use unfamiliar curriculum resources in new ways.

The idea that one's stance toward curriculum materials in teaching develops over time is further supported by our finding that 3 of the 4 teachers who we identified as *thorough pilots* of the materials were relatively new teachers. These teachers

did not have established repertoires of curriculum use and were open to the guidance a published curriculum could offer, particularly one that reflected their ideas about mathematics teaching and learning. This pattern contrasts with Ball and Feiman-Nemser's (1988) finding that student teachers in two teacher preparation programs developed negative impressions of textbooks and teacher's guides and tended to believe that good teachers did not follow the textbooks but created their own lessons and materials. The difference in these findings may reflect a change that occurs for beginning teachers once they take on the full responsibility of teaching, as was found by Kauffman, Johnson, Kardos, Liu, and Peske (2002). However, the difference might also signal changes in the way curriculum resources are viewed by teacher educators and their students within the current reform context. After all, available curriculum resources have changed significantly since the publication of the NCTM's *Curriculum and Evaluation Standards for School Mathematics* in 1989.

A final issue arising out of our analysis of the relationships between teachers' orientations toward curriculum materials and opportunities for learning is the possibility for change. Although we observed considerable stability in the way the teachers used the Investigations curriculum, we also noted changes in these patterns for at least two teachers. In both cases, these changes occurred as a result of the teachers learning through using the curriculum over an extended period of time. In other words, teachers' orientations toward curriculum materials are not necessarily static and using a Standards-based curriculum, even in minimal ways, may lead to some change in the factors that contribute to this orientation and their subsequent use. It is through this process that Standards-based curriculum materials can support teacher learning.

IMPLICATIONS

Our findings lead us to several implications for future research and practice. Considering that most Standards-based curriculum materials are designed to speak *to* teachers, rather than *through* them, together with the variation we and others observed in how and whether teachers read this information, the field would benefit from greater understanding of how teachers engage curriculum materials that are unfamiliar in format and content. In particular, comparisons of teachers' reading processes across different Standards-based curricula would shed light on the role that specific features of curriculum materials play in this process.

Another finding that calls for more research is the pattern of orientation and use we observed among the three new teachers in contrast to those observed amongst most of the experienced teachers. Given the small number of teachers in our study, we are not able to claim that this pattern would hold up across larger numbers of beginning teachers. However, further comparative studies of experienced and novice teachers using Standards-based curriculum resources could contribute to research on teacher development and its role in teachers' orientations toward curriculum materials and teacher learning.

Because the changes we observed in some of the teachers' uses of Investigations did not occur until after a year or more of using the curriculum, it is evident that longitudinal research is necessary to understand fully the potential for reform-oriented curriculum resources to support teacher learning. This study took place during the first 2 years of a 5-year study. Thus, we anticipate that over time we will have more insights about how curriculum materials contribute to teacher learning and pedagogical change. Still, even the data collected over the first 2 years has implications for practice. We discuss these below.

Our findings confirm that Standards-based curricula are not a panacea, but they can play an important role in fostering reform-based practices. However, without additional support for teachers, the impact of these curriculum materials is likely to be unpredictable and varied. Teachers using curricula like Investigations would benefit from opportunities to explore the content of the materials and have conversations with others about how they use them. The goal of such interactions should be to help teachers engage with the materials and develop new ways of interacting with and using curriculum resources. In particular, teachers need opportunities to interpret information written to them in these resources and consider ways that these insights might figure into their interpretations of students' work and decision making while teaching.

The idea that Standards-based curriculum materials are designed to be used in significantly different ways than those they are replacing has implications for teacher education as well. Many perspectives on teacher-text relationships tend to place the teacher and the text at odds with one another, each vying for the same authority over curricular decisions (cf. Russell, 1994). This perspective is likely to be emphasized in teacher education programs designed to prepare teachers to be skilled in curriculum development (Ball & Feiman-Nemser, 1988). Instead, preservice teachers should be encouraged to develop interactive, rather than antagonistic, relationships with textbooks and curriculum guides. Teacher education programs should provide aspiring teachers with opportunities to critically analyze curriculum materials, to examine the mathematical and pedagogical assumptions implicit in their design, and to consider how curriculum materials might be read, used, and adapted. The intent of these activities would be to help prospective teachers begin to develop stances toward materials that are collaborative and open to future evolution.

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Authors

Janine T. Remillard, Graduate School of Education, 3700 Walnut Street, University of Pennsylvania, Philadelphia, PA, 19104-6216; janiner@gse.upenn.edu

Martha B. Bryans, Friends School Haverford, 851 Buck Lane, Haverford, PA 19010; mbryans@friendshaverford.org